and gave rise to a long discussion. The paper was illustrated by a large number of wall diagrams which covered the whole side of the theatre. The author treated his subject in a comprehensive manner, going into the question historically, and dealing with gas furnaces of almost all kinds; many of the types described being indeed only interesting from a historical standpoint, as they had not proved valuable from an economic point of view. As Mr. Dawson said, however, one often learns as much from failures as from successes; and it is necessary at times to know what to avoid in order to know what to imitate.

From what we have said it will be evident that we cannot hope to follow the author into his description of the many types of gas furnaces he deals with, both from limitations of space, and also from lack of the pictorial aids he had called in, by means of the diagrams, in describing the arrangements of the furnaces. We must therefore confine ourselves to the broad features of the paper, and refer those of our readers who wish to follow up this most interesting subject to the Transactions of the Institution.

The author commenced by stating that the greater number of gas furnaces in which crude heating gas has been successfully applied, have been of the reversing regenerative type. There are many processes, however, requiring temperatures below that maintained by the use of regenerators, and in these gas furnaces have also been used with success. It is also often an advantage to be able to concentrate in one spot the manipulation of all the fuel required in scattered furnaces. For these reasons, amongst others, it is often desirable to employ gas fuel when the cost of saving in fuel may be a secondary consideration. The annealing of steel castings, heating plates and angle bars, &c., are cases in point. On the other hand, there are cases in which a higher temperature is required, such as cannot be attained by combustion of gas with cold air, and in these continuous regeneration—as opposed to reversing regeneration—may be applied; the regeneration having the effect of recovering the heat from the waste gases. In either case the escaping gases must retain sufficient heat to secure the necessary draught; in fact regeneration may be carried too far. The author gives a useful word of warning on this point, some designers being of opinion that they cannot have too much of the good thing, regeneration. There have been many failures due to a want of appreciation of this point.

The author divides gas furnaces into four classes: (*a*) with reversing regeneration; (*b*) with continuous regeneration; (*c*) non-regenerative; and (*d*) with blowpipe or forced blast.

Furnaces with reversing regeneration (Class *a*) are of several different kinds. (1) The ordinary Siemens furnace, the arrangement of which is well known. (2) The Batho or Hilton furnace, in which the regenerators are above ground. (3) Furnaces in which the air only is regenerated, the gas being admitted direct. (4) Furnaces in which a portion of the waste heat is taken back to the producer.[1] (5) The regenerative blast-furnace stoves of the Cooper and Whitwell types.

In furnaces with continuous regeneration (Class *b*), the air is heated in flues by radiation or conduction from the bottom of the furnace, and through thin walls which separate the air-flues from the flues that carry the spent gases to the chimney.

In non-regenerative furnaces (Class *c*), the air is admitted to the furnace at atmospheric temperature.

The blowpipe or forced blast furnaces (Class *d*) are of two kinds: firstly, those in which air is supplied at atmospheric temperature by a fan; and secondly, those in which the air is heated by the spent gases by being passed either through coils or stacks of pipes, or else through brick tubes or flues.

For reasons already stated, we cannot follow the author into the details of the various types here broadly sketched. The classification is, however, valuable, and supplies a standard which doubtless will be followed by others when dealing with this subject of daily growing importance.

Before closing our brief abstract of this paper, we will repeat a quotation the author makes from an address of the late Mr. Holley, delivered sixteen years ago, as it does justice to the foresight of that great American engineer and metallurgist, to whom not only his own countrymen, but European engineers also, owe so much. In his Presidential address to the American Institute of Mining Engineers, Mr. Holley said: "Regenerative furnaces will gradually but inevitably take the place of the ordinary heating, puddling, and melting furnaces, thus preventing the application of unspent furnace heat to steam generation." It should be remembered that in those days the generation of steam was looked on, in the general metallurgical trades, as the proper and legitimate means of recovering heat from waste furnace gases. How ill the device served this end those who know the difficulties and dangers of furnace gas fired boilers will recognize.

The discussion on this paper was opened by Mr. Aspinall, the Superintendent of Mechanical Engineering to the Lancashire and Yorkshire Railway, who bore testimony to the successful working of gas furnaces in engineering practice at the company's works at Horwich.

Mr. John Head, who is connected with Mr. Frederick Siemens, also spoke at some length, in the course of his speech dealing with the new Siemens furnace, and giving instances of its successful working.

Mr. Smith-Casson, of Lord Dudley's Round Oak Iron Works, also gave interesting particulars of a furnace he had designed and erected. This furnace has overhead regenerators, a type which is now attracting a good deal of attention. It is interesting to note that Mr. Smith-Casson does not advocate overhead regeneration in all circumstances. It is a subject, he said, upon which he has still an open mind. As another speaker pointed out, there is this objection to an elevated regenerator, that the heated air naturally rises to the highest point, and therefore the circulation may not be as efficient as in cases where the regenerators are placed below the hearth.

Mr. A. Slater described a device in an ordinary boiler furnace in which iron retorts are placed at the back of the furnace bridge, and in these steam is dissociated and returns to the furnace for combustion of the gases. As Mr. Macfarlane Gray pointed out, this appears nearly akin to the perpetual motion theories; but a useful effect may be obtained by transferring heat from a place where it is not wanted to a place where it is. Mr. Slater said the application of this device gave a saving of 38 per cent. of fuel burnt, which only proves that Mr. Slater's boilers must have been of extremely bad proportions originally.

A good deal of the discussion turned on the burning of gaseous fuel in steam-boilers. In connection with this subject we cannot do better than quote a remark made by Prof. Alexander Kennedy. As to the saving of burning gas with regenerative furnaces in metallurgical operations, there can be but little divergence of opinion; but in the case of generation of steam, quite a different set of conditions will arise. In steel-making, for instance, it is necessary that there should be intense local heat, and the gases must leave the furnace at an enormously high temperature. In boiler furnaces intense local heat is to be avoided, and the products of combustion pass to the chimney comparatively cool. Thus a steam-boiler may show an evaporative efficiency or fuel economy so high that little more heat is left in the spent gases than is necessary to supply chimney draught, and in such a case regenerators would be useless. In metallurgical operations the efficiency of the furnace would be something absurdly low without regenerators, perhaps not more than 5 per cent. We commend these remarks to those visionaries who think that so much better results can be obtained by complicated gas-generating devices in steam-boilers, than by burning coal simply logically on a grate.

The paper of Mr. Bagshaw was of a nature which confined its interest chiefly to practical founders, and does not require extended notice at our hands.

The summer meeting of the Institution will be held at Liverpool during the last four days of July.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for January contains:—Studies on the comparative anatomy of sponges, by Arthur Dendy, M.Sc.: (3) On the anatomy of *Grantia labyrinthica*, Carter, and the so-called family Teichonidæ (plates i. to iv.). In the introduction to this paper the author refers to the large collection of sponges made by Mr. Bracebridge Wilson in the neighbourhood of Melbourne, during the last few years, numbering about 2000 specimens. This series, as well as the collection in the National Museum at Melbourne which has been placed at his disposal by Sir F. McCoy, he hopes to name and describe in time; but as such a work must extend over some years, he purposes from time to time to note new or important

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[1] This is the new Siemens furnace which was fully described in a paper read before the Iron and Steel Institute, by Mr. John Head, in 1889.

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forms. The present paper describes a large and beautiful calci-sponge, originally described by Mr. Carter as *Trichonella labyrinthica*, but better located in the genus Grantia as defined by Vosmaer. It is very large for a calcareous sponge, well-grown specimens being about three inches in height and a little more in breadth. In adult forms there is a stout cylindrical stem surmounted by a greatly convoluted cup-shaped mass. Into the detailed description it would be impossible to enter; but in regard to the recent controversy about the existence of "Sollas's membrane" it may be mentioned that in this species this membrane remains visible even when the collars of the cells are retracted, thus indicating that it is probably a more or less permanent structure, and no mere temporary fusion of the margins of adjacent collars. As to the family Teichonidæ, it must be abandoned, and this branch of Lendenfeld's genealogical tree has to be cut off. (4) On the flagellated chambers and ova of *Halichondria panicea* (plate v.). In this study the minute structure of the above portions of this common British sponge are described from specimens killed with osmic acid. In this sponge the collared cells, when the chamber is seen in section, stand some little distance apart from each other. They have short nucleated bodies, surmounted by delicate funnel-shaped collars; these are all connected at their margins by a very distinct membrane, and the flagella of the collared cells were seen plainly projecting through the collars and into the cavity of the chamber; thus the question of the co-existence of Sollas's membrane and the flagella is settled. The ovum possesses a nucleus with a nuclear membrane and nucleolus, and it is suspended by a pedunculated envelope in the lacuna.—On *Megascolex cæruleus*, Templeton, from Ceylon; together with a theory of the course of the blood in earthworms, by Dr. A. G. Bourne (plates vi. to ix.). During a short visit in 1889 to Ceylon the author obtained thirty-eight species of earthworms; only seven of these have been found in India, and about twenty-nine Indian species have not yet been found in Ceylon. The author summarizes his theory of the circulation as follows: the vascular system consists of a portion in the cephalized region, and of other portions metamerically repeated in all succeeding segments. The cephalized portion differs only from that occurring in any other segment in having undergone a synthesis, and also in the presence of contractile hearts. Throughout the body, blood is forced from the contractile vessels into the peripheral networks; thence it is conveyed by a system of intestino-tegumentary vessels to intestinal capillaries, and from these it returns to the contractile vessels.—On a little-known sense-organ in Salpa, by A. B. Lee (plate x.). This organ, mentioned and figured by Ussow in 1876, seems not to have been since alluded to; Ussow's figures are very imperfect. The organ appears to be either a taste bulb, or as the author inclines to think, "a sensory areometer or hydrometric apparatus."—Immunity against Microbes (Part I*a*), by M. Armand Ruffer.

Bulletin de la Société des Naturalistes de Moscou, 1890, No. 1.—Ornithological fauna of the Amu-daria region, from Tchardjui to Kelif, by M. Zarudnoi. The monograph mentions 159 species of birds, of which 138 nest within the region itself (116 in its cultivated part, 37 in the neighbouring desert, and 25 in towns). Hardly ten more species can be found which nest in the region. Many of the enumerated species are very scarcely represented. The deserts in the north of the Amu have almost the same bird-fauna as the Transcaspian region, although they differ as to their amphibians and reptiles; while further north, in Khiva, M. Bogdanoff found, as known, a much richer bird-fauna, probably due to the proximity of Lake Aral. The enumeration of species is accompanied by short notes relative to their habitats and feathering; some measurements are also given.—The system of chemical elements, by B. Tchitchérine (in French). This most valuable work, the importance of which was pointed out by Prof. Mendeleeff in his Faraday Lecture, is summed up for the *Bulletin*. The researches of the author into the numerical laws of the system bring him to a most interesting hypothesis relative to the structure of simple bodies; it evidently cannot be dealt with in a short note.—Studies as to the development of Amphipods, Part 4, by Mme. Marie Rossiiskaya-Koschewnikowa, being the history of development of the *Sunamphitoë valida*, Czerniawski, and the *Amphitoë picta*, Rathke (in French, with plates).—The Cladoceræ of the neighbourhood of Moscow, by Paul Matile (in German, with plates). The species *Daphnia dentata*, *Ceriodaphnia setosa*, and *Macrothrix borysthenica* are new.—Note on the Spongillidæ of the neighbourhood of Moscow, by W. Zykoff.

No. 2.—The Neocomian deposits of the Vorobievo Hills (near Moscow) by A. Pavloff (in French). The ferruginous sandstones and sands lodged between the Volgian (intermediate between Cretaceous and Jurassic) deposits and the ground moraine of the great ice-sheet are supposed to belong to the Cretaceous age, Wealdian, and Neocomian. The following fossils testify the Cretaceous age of the brown sandstone: *Olcostephanus* (*Ammonites*) *discofalcatus*, Lah.; *O. progrediens*, Lah.; *O. Decheni*, Röm. (not Weerth); and *Crioceras Matheroni*, D'Orbigny.—On the Turgaisk meteorite, by E. D. Kislakovsky. It was discovered by Kirghizes in 1888, when tilling the soil at Bish tube, in the Nikolaevsk district of the province of Turgai, and consisted of two pieces—one about 70 pounds and the other about 36 pounds. The bigger one was bought by M. Nazaroff, who discovered also a third fragment (205 grammes) which was found some 3 feet north of the preceding. It has been given to the Moscow Society, and M. Kislakovsky's paper (illustrated by one plate) contains the results of its chemical analysis.—A catalogue of Lepidoptera of the Kazan province; Part 1, Rhopalocera, by A. Krulikovski (in Russian). The Lepidoptera of Kazan are very interesting, no fewer than 144 species of diurnal butterflies being already described by the author.—The *Tomicus Judeichii*, Kirsch., by Th. Teplouchoff (in German, with a plate). Its supposed identity with *T. duplicatus*, Sahlb., is discussed. Though formerly considered as a Uralian species, it has now been found all over middle Russia, as far as Courland.—On the history of development of *Hydrodictyon utriculatum*, Roth., by A. Artari (in German, with a plate).—Zoological researches in the Transcaspian region (continued), by N. Zarudnoi. Thirty-six species of reptiles and three amphibians are mentioned, and the catalogue of Mammalia and birds is completed according to observations made in 1889.

SOCIETIES AND ACADEMIES.

LONDON

Physical Society, January 16.—Prof. W. E. Ayrton, F.R.S., President, in the chair.—The thanks of the meeting were unanimously accorded to the Maxwell Memorial Committee for presenting to the Society a copy of Maxwell's scientific papers.—Prof. G. M. Minchin read a paper on Photo-electricity. His experiments on the subject were commenced in 1877, in attempting to produce a photographic image of a distant object. The result sought for has not hitherto been obtained, but the experiments have led to the discovery of many interesting phenomena. Some of these were shown to the meeting. Electric currents are produced by the action of light on silver plates coated with collodion or gelatine emulsions of bromide, chloride, iodide, or other silver salts, or with eosine, fluorescine, and other aniline dyes, when the plates are immersed in a suitable liquid and one plate illuminated whilst the other is screened. The directions of the currents depend on the materials employed, and the blue end of the spectrum is most effective. Currents have a photographic effect on the plates, and this action is strictly confined to the parts through which the current has passed. Comparatively strong currents were obtained from plates coated with eosine and gelatine. A curious reversal was observed with some cells, the exposed plate first being positive to the screened one, and almost immediately afterwards became negative. On shutting off the light, a transient increase of current resulted, and afterwards disappeared gradually. M. Becquerel, who has studied the action of silver plates coated with bromide, &c., concludes that the nature of the exposed plate (whether positive or negative) depends on the thickness of the surface layer. The electromotive force of such cells rarely exceeds $\frac{1}{20}$ of a volt. Uncleaned tinfoil plates in common tap water give a current when one is exposed to light and the other screened. Cleaning the plates destroys the effect. In nearly every case the exposed plate was first positive, and after a time became negative; and, by exposing various parts of a plate (some portions of which had been previously exposed), the currents could be varied in direction at will. These peculiarities may explain the known divergence of tin from Volta's law. The phenomena have also been studied by aid of the electrometer. Tinfoil obtained from tobacco packages was found to be very sensitive to light. One side of such foil is dull and the other bright, and, by pasting slips of it on opposite sides of a glass plate, so that dissimilar sides were outermost, and immersing them in alcohol,

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